

AMENDED CLAIMS

[received by the International Bureau on 11 April 2005 (11.04.2005);
original claims 1-2, 7-8, 10-13 amended; new claims 16 and 17 added; remaining claims unchanged]

1. An adaptive feed-back controlled cardiac resynchronisation therapy system with a dynamic AV delay and VV interval pacing parameters
5 wherein said parameters are changed in correlation with the data of at least hemodynamic sensor continuously monitoring a hemodynamic performance, said system comprising:
 - a learning neural network module for receiving and processing information of said at least one sensor and for
10 learning at least one physiological aspect of said body;
 - a deterministic algorithmic module receiving parameters from said neural network module and for supervising online said learning module, and
 - a therapeutic delivering means connected to said
15 deterministic algorithmic module.
2. A system according to claim 1 wherein said modules and therapeutic delivery means are implanted, delivering biventricular
20 pacing with adaptive AV delay and VV interval, modified continuously with correlation to the hemodynamic performance of the heart.

3. A system according to Claim 1 wherein said neural network module employs a spiking neuron network architecture.
4. A system according to Claim 3 wherein said neural network module employs a spiking neuron network architecture implemented as a silicon processor operating at with extremely low clock frequency.
5. A system according to claim 1 wherein said neural networks module is external.
6. A system according to claim 1 wherein said at least one sensor is a non invasive sensor.
7. A system according to claim 1 wherein said therapeutic delivery system is connected to said learning neural network module via a wireless communications link.
8. A system according to claim 1 wherein said therapeutic delivery means are at least one selected from the group consisting of pacemaker, defibrillator.
9. A method for regulating a controlled delivery of a physiologically active agent to a patient comprising the steps of:

- obtaining continuous signal from at least one sensor monitoring said patient;
- processing said continuous signal by an algorithmic processing module and a learning module, and wherein said learning modules carries out adaptive learning in connection with said at least one sensor is first supervised by applying an accepted set of parameters , and
- affecting a delivery module in accordance with said processing, wherein said affect either results from said algorithmic process or from said learning processing.

10. A method for regulating a controlled delivery of a physiologically active agent as in claim 9 wherein said learning module is a neural network module.

11. A method for regulating a controlled delivery of a physiologically active agent as in claim 10 wherein said synaptic weight change is a Hebbian.

12. A method for adaptive biventricular pacing control as in claim 9 comprising the steps of:

- programming initial AV (atriaventricular) delay parameter
and VV (interventricular delay) interval parameter of an
algorithmic module;
- operating in normal CRT mode wherein an algorithmic
deterministic module for controlling delivery of pulses,
wherein pacing is carried out according to said
parameters and wherein learning operation with said
parameters takes place, and
- transition to adaptive CRT mode wherein said AV delay
and VV interval change dynamically in order to achieve
optimal hemodynamic performance, and wherein said
adaptive mode is limited to perform in a predefined low
limit of hemodynamic performance.

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13. A method for adaptive biventricular pacing control as in claim 12 wherein optimised biventricular pacing based on the information of at least one hemodynamic sensor are delivered at all heart rates.

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A method for adaptive biventricular pacing control as in claim 13 wherein said information relates to implanted ventricular pressure sensor.

15. A method for adaptive biventricular pacing control as in claim 13 wherein said information relates to ventricular impedance implanted sensor.

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16. A method for a controlled delivery of a physiologically active agent as in claim 9 wherein said physiologically active agent is insulin.

17. A method for a controlled delivery of a physiologically active agent as in claim 9 wherein said physiologically active agent is a brains stimulating agent.

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STATEMENT UNDER ARTICLE 19 (1)

System claim 1 was amended to restrict the scope to cardiac treating devices, and to indicate as follows: the haemodynamic sensor monitors the heart continuously, on line.

Dependent system claim 2 was amended to comply with the new claim 1.

The present invention combines an on-line learning module with a supervising deterministic module that resets the learning module if unrealistic pacing is about to occur.

With the present invention device, pacing is delivered in correlation with continuously measured online hemodynamic performance and there is no need to use the prior art pre-defined maximal tracking rate limit.

The present invention implements spiking neural network and a novel Hebbian learning rule for the adaptation of the synaptic weights online and continuously in correlation with the hemodynamic sensor's information, performing the feedback control task.

The present invention provides a hybrid micro-controller hardware that combines deterministic computation with a non-deterministic learning module, such as a neural network module system. The micro-controller is a master in the hybrid system and ensures safety and reliability operational limits of the hybrid controller. In this and other respects, the novel spiking neuron network implemented in hardware silicon dissipates extremely low power since it operates with low clock frequency of 1 KHz.